APPENDIX C
DESIGN EXAMPLES

I. PRESSURE FILTER

Assume: Average hydraulic loading =	2 gpm/ft2	80 L/(min m2)
Peak hydraulic loading =	5 gpm/ft2	200 L/(min m2)
Average plant flow =	100 gpm	400 L/min
Peak plant flow =	200 gpm	800 L/min
Total suspended solids =	30 mg/L	

Dual media filter of Anthracite and Filter Sand

Filter Area:

$$Filter\ Area_{avg} = \frac{400\ L/\text{min}}{80\ L/(\text{min}\cdot m^2)} = 5\ m^2\ (54\ ft^2)$$

$$Filter\ Area_{peak} = \frac{800\ L/\text{min}}{200\ L/(\text{min}\cdot m^2)} = 4\ m^2\ (43.5\ ft^2)$$

Choose Filter Area = 50 ft2.

Filter Diameter:

Filter area is determined from standard bed sizes as specified in vendor literature. Assume standard diameters are im, 2m and 3m:

$$Filter\ Area = \pi x \frac{1^2}{4} = 0.8\ m^2\ (8.7\ ft^2)\quad [for\ /m\ dia.]$$

$$Filter\ Area = \pi x \frac{2^2}{4} = 3.1\ m^2\ (33.7\ ft^2)\quad [for\ 2m\ dia.]$$

Given standard bed sizes, choose the bed with the closest dimensions to the 8* diameter. If dual filters are required,

$$\textit{Filter Area} = \pi x \frac{3^2}{4} = 7.1\ m^2\ (77.2\ ft^2)\quad [\textit{for 3m dia.}]$$

choose two 6* diameter skid—mounted filters with areas adding to 56.6 ft.. These dimensions are conservative to obtain the desired 50.0 ft^2 area.

Solids Loading:

$$\textit{Solids Loading} = 0.01199 \times 2\ gpm/ft^2 \times 30\ mgJL = 0.719\ lbs/ft^2/day = (3.51\ kg/(m^2 \cdot d))$$

Calculate Filter Piping Requirements:

Influent Pipe:

$$\textit{Maximum Flow} = 5\ gpm/ft^2 \times 50\ ft^2 - 250\ gpm = 946.3\ L/\text{min} = 0.56\ cfs$$

General sizing criteria is as follows: list the ranges (i.e., influent is 1—4 fps, effluent is 3—6 fps, etc.).

Design influent pipe for a velocity of 2 fps (0.61 m/s) at the maximum flow:

$$\textit{Required Influent Pipe Area} = \frac{0.56\ cfs}{2\ fps} = 0.28\ ft^2\ (523\ mm^2)$$

Velocities of different pipe sizes:

Influent Line Size (in.) / (mm)	Area (ft^2) / (m^2)	Velocity at Max. Flow (fps) / (m/s)
4 / 100	0.0873 /0.008	6.41 / 1.95
6 / 150	0.196 / 0.018	2.86 / 0.87
8 / 200	0.349 / 0.032	1.60 / 0.49

Select 6 in. (150 mm) diameter pipe since its velocity falls within the optimum range of 1-4 fps (0.3 - 1.2 m/sec). The 8 in. (200 mm) diameter pipe also falls in the range. An 8 in. pipe costs more than a 6 in. pipe. As long as the pipe run is not long, the extra HL from the 6 in. pipe should not be significant.

Effluent Pipe:

Design effluent pipe for a velocity of 4 fps at the maximum flow of 0.56 cfs:

$$\textit{Required Effluent Pipe Area} = \frac{0.56\ cfs}{4\ fps} = 0.14\ ft^2\ (130\ mm^2)$$

Velocities of different pipe sizes:

Effluent Line Size (in.) / (mm)	Area (ft^2) / (m^2)	Velocity at Max. Flow (fps) / (m/s)
4 / 101.6	0.0873 /0.008	6.41 / 1.95
6 / 152.4	0.196 / 0.018	2.86 / 0.87
8 / 203.2	0.349 / 0.032	1.60 / 0.49

Use the 150 mm (6 in.) diameter pipe since its velocity falls closest to the optimum range of 1 – 2 m/s (3-6 fps).

Sizing all other system piping (e.g., backwash pipe, filter-to-waste pipe), the procedure for sizing the influent and effluent pipes should be followed.

Select type of media to be used based on the application and calculate clean–bed headlosses through the media at various loading rates. In the example, 18 inches of anthracite over 12 inches of filter sand is used to show the procedure.

Anthracite Media Specifications:

Effective Size:	0.80 mm to 0.90 mm
Uniformity Coefficient:	Not greater than 1.5
Depth:	18 inches

Headloss through anthracite is calculated using empirical equations. In this example, the core equation developed by Fair & Hatch is used:

$$h/l = \frac{k}{g} v \mu \frac{(1-\alpha)^2}{\alpha^3} \left(\frac{6}{y}\right)^2 \sum_{L=1}^{n} \frac{\rho}{d_i^2}$$

where:
- k = coefficient of permeability = 5.0
- g = gravity constant = 981 cm/sec^2
- μ = dynamic viscosity = 0.895 x 10^{-2} g/cm-sec
- " = porosity = 0.55
- v = approach velocity in cm/sec
- y = sphericity.

Calculate the value of $\sum_{L=1}^{n} \frac{\rho_i}{d_i^2}$ in a manner as shown in the following sheet and calculate value of headloss per length of filter depth in terms of approach velocity. For anthracite in this example:

h/l = 0.32 v

h = 5.76 v (inches) for 18″ of media.

Loading Rate (gpm/ft^2)	v Approach Velocity (cm/sec)	h_L (in) / (m)	h_L (ft)
1.0	0.07	0.40 / 0.009	0.03
2.0	0.14	0.81 / 0.02	0.07
3.0	0.20	1.15 / 0.03	0.10
4.0	0.27	1.56 / 0.04	0.13
5.0	0.34	1.96 / 0.05	0.16

Anthracite Filter Media - 0.80 mm to 0.90 mm Effective Size

Sieve	Sieve Size (mm)	Sand Layer Smaller Than Stated Size (%)	Sand Fraction Within Adjusted Sieve Sizes (%)	Geometric Mean Diameter, d_i (mm)	$\frac{\rho_i}{d_i^2}$
40	0.420	0	1	0.500	4
30	0.595	1	2	0.650	5
25	0.710	3	5	0.777	8
20	0.850	8	14	0.922	16
18	1.00	22	25	1.09	21
16	1.18	47	20	1.29	12
14	1.40	67	26	1.54	11
12	1.70	93	7	1.84	2
10	2.00	100			
SUM	...	...	100		79

$\frac{\rho_i}{d_i^2}$ is calculated using units of cm. for geometric mean diameter and decimal fraction for ρ_i or units of mm for geometric mean diameter and % for ρ_i .

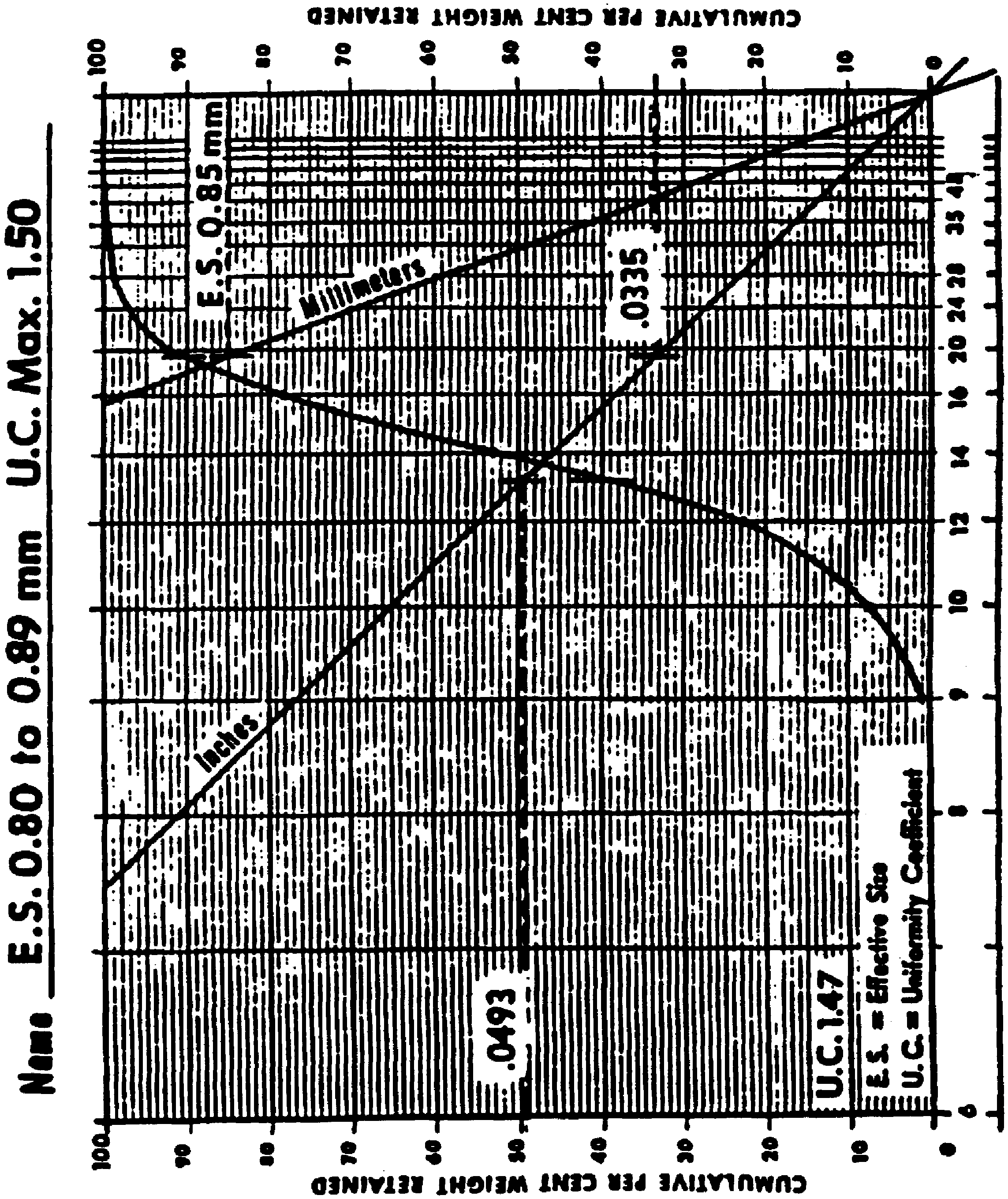


FIGURE C-1. ANTHRACITE MEDIA GRADATION ANALYSIS.

Sand Media Specifications:

Effective Size:	0.45 mm to 0.55 mm
Uniformity Coefficient:	Not greater than 1.6
Depth:	12 inches

Similar to anthracite media, clean–bed headloss for sand media is calculated using the empirical equation:

$$h/l = \frac{k}{g} v \mu \, \frac{(1-\alpha)^2}{\alpha^3} \left(\frac{6}{y}\right)^2 \sum_{L=1}^{n} \frac{\rho}{d_i^2}$$

where:
k = coefficient of permeability = 5.0
g = gravity constant = 981 cm/sec^2
μ = dynamic viscosity = 0.895 x 10^{-2} g/cm-sec
" = porosity = 0.42
6/y = 7.5
v = approach velocity in cm/sec

Calculate the value of $\sum_{L=1}^{n} \frac{\rho_i}{d_i^2}$ in a manner as shown in the following sheet and calculate value of headloss per length of filter depth in terms of approach velocity. For sand in this example:

h/l = 2.91 v

h = 34.9 v (inches) for 12″ of media.

Loading Rate (gpm/ft^2)	v Approach Velocity (cm/sec)	h_L (in)	h_L (ft) / (m)
1.0	0.07	2.44	0.20 / 0.06
2.0	0.14	4.89	0.41 / 0.12
3.0	0.20	6.98	0.58 / 0.18
4.0	0.27	9.42	0.79 / 0.24
5.0	0.34	11.9	1.0 / 0.30

Filter Sand Media - 0.45 mm to 0.55 mm Effective Size

Sieve	Sieve Size (mm)	Sand Layer Smaller Than Stated Size (%)	Sand Fraction Within Adjusted Sieve Sizes (%)	Geometric Mean Diameter, d_i (mm)	$\frac{\rho_i}{d_i^2}$
45	0.355	0	1	0.388	7
40	0.425	1	11	0.46	52
35	0.500	12	18	0.548	60
30	0.600	30	25	0.653	59
25	0.710	55	30	0.777	50
20	0.850	85	15	0.922	18
18	1.0	100			
SUM	...	...	100	...	246

$\frac{\rho_i}{d_i^2}$ is calculated using units of cm. for geometric mean diameter and decimal fraction for ρ_i or units of mm for geometric mean diameter and % for ρ_i.

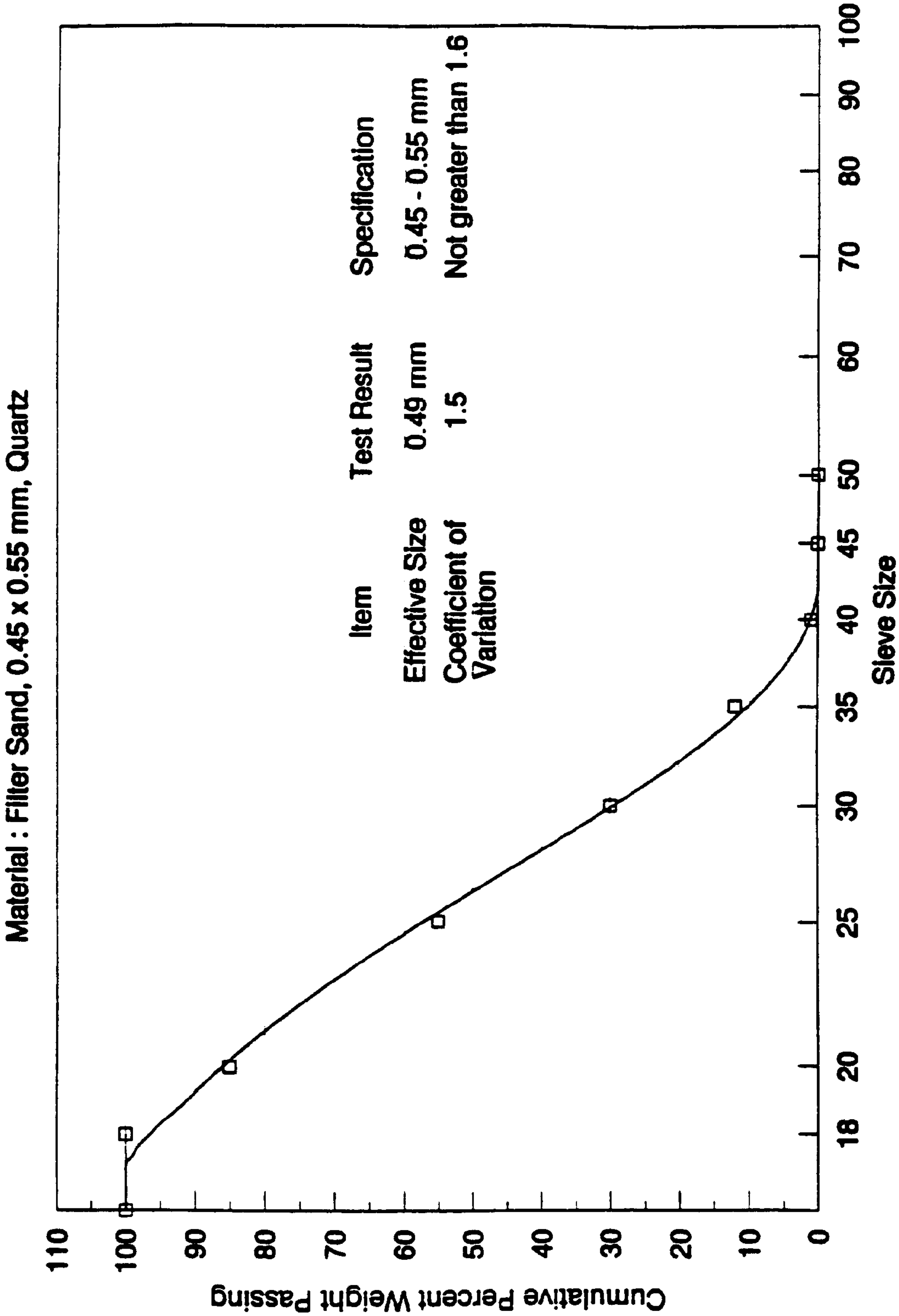


FIGURE C-2. FILTER SAND MEDIA GRADATION ANALYSIS.

Summary of Head Losses Through Filter Cell

Calculate combined headloss through the filter for anthracite and sand media layer:

	H_L at 1.0 gpm/ft^2 (ft)/(m)	H_L at 2.0 gpm/ft^2 (ft)/(m)	H_L at 3.0 gpm/ft^2 (ft)/(m)	H_L at 4.0 gpm/ft^2 (ft)/(m)	H_L at 5.0 gpm/ft^2 (ft)/(m)
18" Anthracite	0.03 / 0.009	0.07 / 0.02	0.10 / 0.03	0.13 / 0.04	0.16 / 0.05
12" Filter Sand	0.20 / 0.06	0.41 / 0.12	0.58 / 0.18	0.79 / 0.24	1.0 / 0.3
SUM	0.23 / 0.07	0.48 / 0.15	0.68 / 0.21	0.92 / 0.28	1.16 / 0.35

Calculate Backwash Rate and Media Expansion during Backwashing:

Calculate the backwash rate required to fluidize the anthracite and sand media at the highest fluid temperature expected. The d_{90} size particle, those for which 90 percent and smaller than, is normally utilized for calculation of minimum fluidization velocity.

Backwash Rate For Anthracite:

Backwash rate required to fluidize anthracite media with effective size (e.s.) of 0.80 mm – 0.90 mm and a U.C. of 1.5:

– Calculate d_{90}:

$$d_{90} = (1.68\ \text{U.C.} - 0.68)\ d_{90}$$

$$= ((1.68)\ (1.5) - 0.68)\ 0.85$$

$$= 1.56\ \text{mm} = 0.0016\ \text{m}$$

- Calculate V_{mf}, the superficial velocity at point of minimum fluidization:

$$V_{mf} = \frac{R_{emf}\mu}{d_{eq}\rho}$$

$$R_{emf} = [(33.7)^2 + 0.0408\,G_a]^{0.5} - 33.7$$

$$G_a = d_{eq}^{\ 3}\,\rho\,(\rho_s - \rho)\,\frac{q}{\mu^2}$$

where: Remf= Reynolds number at minimum fluidization,
μ= viscosity of fluid at temperature T,
p= mass density of fluid at temperature T,
Ga= Galileo number,
ps= mass density of media particles,
deq= use d_{90} as approximation of d_{eq},
q= gravitational constant, 9.8066 m/sec^2.

For this example, use the following constants:
T= 300 C, 86°F
μ= 0.798 x 10-3 kg/m sec
p= 995.65 kg/m3
ps= 1,695 kg/m3 (Specific gravity = 1.7)
deq= d90 = 0.0016 m

Using the above equation and constants, calculate the Galileo (Ga) and Reynolds (R_{emf}) numbers:

Ga = 43,962 and R_{emf} = 20.42

Using the above equation, constants, Ga and Remf, calculate the Superficial Velocity:

V_{mf} = 0.0103 in/sec = 1.03 cm/sec.

- Calculate the Minimum Backwash Rate for Anthracite Fluidization:

Increase the calculated superficial velocity by an additional 30 percent for design purposes for assurances to provide adequate backwash capability.

Minimum Backwash Rate for Fluidization = 1.3 V_{mf}

1.3 V_{mf} = (1.3)(1.02) = 1.33 cm/sec = 0.0133 in/sec = 18.9gpm/ft^2

- Calculate the Anthracite Media Expansion:

Using a backwash rate of 20 gpm/ft and a water temperature of 30°C,

$$\frac{f_{ei}^3}{(1-f_{ei})} = \frac{k}{g}\frac{\mu}{(\rho_s-\rho)}v\left(\frac{6}{yd_i}\right)^2$$

(equation 27—18, pg 27—20, Fair & Geyer)

where:	fei=	porosity of the ith layer,
	k=	function of fei = 4 when media fluidizes,
	g=	gravitational constant, 981 cm/sec2,
	μ=	0.8004 x 10—2 gm/cm sec,
	ps=	1.6 gm/cm3,
	p=	0.99568 gm/cm3,
	y=	0.70
	v=	1.35 cm/sec.

$$\frac{f_{ei}^3}{(1-f_{ei})} = \frac{0.0054}{d_i^2}$$

— Calculate Total Expansion of Anthracite Layer at 20 gpm/ft^2 wash rate:

$$L_e = L(1-f)\sum_{i=1}^{n}\frac{\rho_i}{(1-f_{ei})}$$

where:	Le=	Expanded depth of media
	L=	Depth of unexpanded media
	p=	porosity of unexpanded media
	po=	media fraction within adjacent sieve sizes
	fei=	porosity of expanded layer i

— Calculate values of $\sum_{i=1}^{n} \frac{\rho_i}{(1-f_{ei})}$ as shown in the following sheets.

Using the above constants and equation, calculate the layer expansion (L_e):

Le = 18.63″

Percent Expansion = [(18.63 - 18)/18] x 100
=4%

— Calculate Porosity of Expanded Bed at 20 gpm/ft^2

$$L_e = L\left(\frac{1-f}{1-f_e}\right)$$

L_e = 18.63″ (473 mm)
L = 18.0″ (457 mm)
f = 0.55

$$f_e = (-1)\left[\frac{L}{L_e}(1-f) - 1\right]$$

fe = 0.57

Filter Bed Expansion Calculations
Anthracite Media, e.s. 0.80 mm - 0.90 mm, 20 gpm/ft^2 Wash Rate (1.35 cm/sec)

Size of	d_i (2)	d_i^{-2}	ρ_i	$\frac{f_{ei}^3}{1-f_{ei}}$	$\frac{1}{1-f_{ei}}$	$\frac{\rho_i}{1-f_{ei}}$
0.042 cm	(1)			(2)	(3)	
	0.050 cm	400	0.01	2.16	4.54	0.05
0.06						
	0.065	237	0.02	1.28	3.50	0.07
0.07						
	0.078	164	0.05	0.89	3.0	0.15
0.085						
	0.092	118	0.14	0.64	2.64	0.37
0.10						
	0.11	83	0.25	0.45	2.36	0.59
0.12						
	0.13	57	0.20	0.32	2.14	0.43
0.14						
	0.15	44	0.26	0.24	1.98	0.51
0.17						
	0.18	31	0.07	0.17	1.81	0.13
0.20					SUM --->	2.30

(1) d_i = geometric mean - square root of the product of adjacent sizes.
(2) from equation calculated for flow and temperature conditions = $0.0015/d_i^2$.
(3) from Table 27-5, pg. 27-20, Fair & Geyer.

— Calculate values of 1/(1-fe) corresponding to values of $f_e^3/(l-f_e)$, based on Table 27—5, pg. 27—20, Fair & Geyer — Anthracite Media

Anthracite Media

$\frac{f_{ei}^3}{1-f_{ei}}$	Calculations	$\frac{1}{1-f_{ei}}$
2.16	$0.1\ [0.06\ (2.16 - \frac{2.10 - 4.47}{2.20 - 4.58})\ x]\ 0.$ x = (0.06/0.1) (0.11) = 0.07	4.54
1.28	$0.1\ [0.08\ (1.28 - \frac{1.20 - 3.40}{1.30 - 3.52})\ x]\ 0.$ x = (0.08/0.1) (0.12) = 0.10	3.50
0.89	$0.1\ [0.09\ (0.89 - \frac{0.80 - 2.88}{0.90 - 3.01})\ x]\ 0.$ x = (0.09/0.1) (0.13) = 0.12	3.00
0.64	$0.1\ [0.04\ (0.64 - \frac{0.60 - 2.59}{0.70 - 2.74})\ x]\ 0.$ x = (0.04/0.1) (0.15) = 0.06	2.64

0.45		2.36
0.32	$0.1 \; [0.02 \; (0.32 - \frac{0.30 - 2.10}{0.40 - 2.28}) x] \; 0.$ x = (0.02/0.1) (0.18) = 0.04	2.14
0.24	$0.1 \; [0.04 \; (2.40 - \frac{0.20 - 1.8}{0.30 - 2.10}) x] \; 0.$ x = (0.04/0.1) (0.21) = 0.09	1.98
0.17	$0.1 \; [0.07 \; (0.17 - \frac{0.10 - 1.62}{0.20 - 1.89}) x] \; 0.$ x = (0.07/0.1) (0.27) = 0.19	1.81

Calculate Headloss through the Anthracite Layer at 20 gpm/ft2:

hl = (SG - 1) (1 - fe) Le

where: SG = specific gravity of the fluid
fe = porosity of expanded bed
Le = Depth of expanded bed.

= (1.6 – 1) (1 – 0.57) (18.63)

= (0.6) (0.43) (18.63)

hl = 4.8″ = 0.40* <—— Head Loss

Backwash Rate For Sand:

Backwash rate required to fluidize sand media with effective size (e.s.) of 0.49 mm (0.45 mm – 0.55 mm) and a U.C. of 1.6:

– Calculate d_{90}:

d_{90} = (1.68 U.C. – 0.68) d_{90}

= ((1.68) (1.6) – 0.68) 0.49

= 0.98 mm

- Calculate V_{mf}, the superficial velocity at point of minimum fluidization:

$$V_{mf} = \frac{R_{emf}\mu}{d_{eq}\rho}$$

$$R_{emf} = [(33.7)^2 + 0.0408\, G_a]^{0.5} - 33.7$$

$$G_a = d_{eq}^{\ 3}\,\rho\,(\rho_s - \rho)\,\frac{g}{\mu^2}$$

where: R_{emf} = Reynolds number at minimum fluidization,
μ = viscosity of fluid at temperature T,
p = mass density of fluid at temperature T,
Ga = Galileo number,
ps = mass density of media particles,
deq = use d90 as approximation of deg,
q = gravitational constant, 9.8066 m/sec2.

For this example, use the following constants:

T = 30o C, 86oF
μ = 0.798 x 10-3 kg/m sec
p = 995.65 kg/m3
ps = 2,600 kg/m3
deq = d90 = 0.98 mm = 0.001 m

Using the above equation and constants, calculate the Galileo (Ga) and Reynolds (Reinf) numbers:

Ga = 23,123 and Remf = 11.90

Using the above equation, constants, Ga and Remf, calculate the Superficial Velocity:

Vmf = 0.0096 m/sec = 0.96 cm/sec.

- Calculate the Minimum Backwash Rate for Fluidization:

Minimum Backwash Rate for Fluidization = 1.3 Vmf

1.3 Vmf= (1.3)(0.96) = 1.25 cm/sec = 0.013 m/sec = 18.42gpm/ft2

- Calculate the Sand Media Expansion:

Using a backwash rate of 49 m/hr (20 gpm/ft) and a water temperature of 30oC,

$$\frac{f_{ei}^3}{(1-f_{ei})} = \frac{k}{g}\frac{\mu}{(\rho_s-\rho)}v\left(\frac{\alpha}{\phi d_i}\right)^2$$

(equation 27-18, pg 27-20, Fair & Geyer)

where: fei = porosity of the ith layer,
k = function of fei = 4 when media fluidizes,
g = gravitational constant, 981 cm/sec2,
μ = 0.8004 x 10-2 gm/cm sec,
ps = 2.6 gm/cm3,
p = 0.99568 gm/cm3,
N = 0.80
"/N = 7.5
v = 1.35 cm/sec.

$$\frac{f_{ei}^{3}}{(1-f_{ei})} = \frac{0.0054}{d_i^2}$$

— Calculate Total Expansion of Sand Layer at 20 gpm/ft^2 wash rate:

$$L_e = L(1-f)\sum_{L=1}^{n} \frac{\rho_i}{(1-f_{ei})}$$

Using the above constants and equation, calculate the layer expansion (L_e):

Le = 15.8″

Percent Expansion = [(15.8 - 12)/12] x 100
= 32 %

- Calculate Porosity of Expanded Bed at 20 gpm/ft2

$$L_e = L\left(\frac{1-f}{1-f_e}\right)$$

Le = 15.8″
L = 12.0″
f = 0.42

$$f_e = (-1)\left[\frac{L}{L_e}(1-f) - 1\right]$$

f_c = 0.56

Filter Bed Expansion Calculations
Sand Media, e.s. 0.45 mm - 0.55 mm, **20 gpm/ft² Wash Rate (1.35 cm/sec)**

Size of	d_i (2)	d_i^{-2}	ρ_i	$\frac{f_{ei}^3}{1-f_{ei}}$	$\frac{1}{1-f_{ei}}$	$\frac{\rho_i}{1-f_{ei}}$
0.04 cm	(1)			(2)	(3)	
	0.045	494	0.12	0.74	2.8	0.34
0.05						
	0.055	331	0.20	0.50	2.44	0.49
0.06						
	0.065	237	0.18	0.36	2.21	0.40
0.07						
	0.075	178	0.27	0.27	2.04	0.55
0.08						
	0.085	138	0.13	0.21	1.91	0.25
0.09						
	0.095	111	0.10	0.17	1.81	0.18
0.10						
0.1					**SUM --->**	**2.27**

(1) d_i = geometric mean - square root of the product of adjacent sizes.
(2) from equation calculated for flow and temperature conditions = $0.0015/d_i^2$.
(3) from Table 27-5, pg. 27-20, Fair & Geyer.

— Calculate values of l/(l-f_e) corresponding to values of f_e^3/(l-f_e), based on Table 27—5, pg. 27—20, Fair & Geyer — Sand Media

Sand Media

$\frac{f_{ei}^3}{1-f_{ei}}$	**Calculations**	$\frac{1}{1-f_{ei}}$
0.74	$0.1\ [0.04\ (0.74 - \frac{0.70 - 2.74}{0.80 - 2.88})\ x]\ 0.14$ **x = (0.04/0.1) (0.14) = 0.06**	2.8
0.50		2.44
0.36	$0.1\ [0.06\ (0.36 - \frac{0.30 - 2.16}{0.40 - 2.28})\ x]\ 0.18$ **x = (0.06/0.1) (0.18) = 0.11**	2.21
0.27	$0.1\ [0.07\ (0.27 - \frac{0.20 - 1.89}{0.30 - 2.10})\ x]\ 0.21$ **x = (0.07/0.1) (0.21) = 0.15**	2.04

0.21	$0.1\ [0.01\ (0.21 - \frac{0.20 - 1.89}{0.30 - 2.10})x]\ 0.21$ **x = (0.01/0.1) (0.21) = 0.02**	1.91
0.17	$0.1\ [0.07\ (0.17 - \frac{0.10 - 1.62}{0.20 - 1.89})x]\ 0.27$ **x = (0.07/0.1) (0.27) = 0.19**	1.81

Calculate Headloss through the Sand Layer at 20 gpm/ft2:

$$h_1 = (SG - 1)(1 - f_c)\ L_e$$

$$= (2.6 - 1)(1 - 0.56)(15.8)$$

$$= (0.6)(0.43)(15.8)$$

$$= 11.12'' = 0.93^* = 282.45\ \text{mm}$$

Sand Media fluidizes at approximately 15 gpm/ft^2 wash rate, at which point headloss remains constant at 0.93*. Losses at lesser wash rates are calculated based on stratified bed loss equation:

$$h_1 = 34.9\ v\ (\text{inches})$$

Loading Rate (gpm/ft^2)	v Approach Velocity (cm/sec)	h_L (in) / (ft)	h_L (m)
5.0	0.34	11.9 / 1.0	0.30
10	0.68	23.7 / 2.0	0.60

* Both Head Losses for stratified beds exceed the Head Loss for Fluidization. Therefore, use the Fluidization Head Loss as a maximum.

II. TRAVELLING BRIDGE FILTER

Assume average hydraulic loading = 2 gpm/ft^2 80L/(min m^2)
peak hydraulic loading = 5 gpm/ft^2 200L/(min m^2)
average plant flow = 100 gpm 400L/min
peak plant flow = 200 gpin 800L/min
total suspended solids = 30 ms/l
single media filter

Filter Area:

$$Filter\ Area = \frac{200\ L/\min}{80\ L/(\min \cdot m^2)} = 5m^2 = 54.3ft^2$$

$$Filter\ Area = \frac{400\ L/\min}{200\ L/(\min \cdot m^2)} = 2m^2 = 21.7ft^2$$

Choose filter area = 50 ft^2 (4.65 m^2)

Filter Length:

Filter length is selected from standard bed sizes. Assume standard widths are 6* and 8*

$$Filter\ Length = \frac{50\ ft^2}{6\ ft} = 8.3\ ft = 2.53\ m$$

$$Filter\ Length = \frac{50\ ft^2}{8\ ft} = 6.25\ ft = 1.91\ m$$

Given standard bed sizes, if one filter is desired, choose the bed with the closest dimensions to either 6* width and 8.3* length or 8* width and 6.25* length. If dual filters are required, choose two 6* filters with lengths adding to 8.3* or greater, two 8* filters with lengths adding to 6.25* or greater, or a combination of 6* (1.8 m) and 8* (2.4 m) width filters with adequate surface area.

Solids Loading:

$$Solids\ Loading = 0.01199\ x\ 2gpm/ft^2\ x\ 30\ mg/l = 0.719\ lbs/ft^2/day\ (3.51\ kg/(m^2 d)$$

Frequency of Backwash:

From Figure 1, Rate of Head loss = 2.25 inches/hour. For a 6″ operating head, the level in the filter will reach terminal head in 2.7 hours (6/2.25 = 2.7). Time to traverse filter (from manufacturer) is 0.1 hours. Total time required from completion of one backwash cycle to the completion of the next backwash cycle is 2.8 hours. This results in 9 backwash cycles per day.

Percent Backwash Water Required:

$$Backwash\ Water\ Required = 60\ gpm\ x\ 6\ \min\ x\ 9\ cycles = 3{,}240\ gallons\ (12{,}265L)$$

$$Throughput = 50\ ft^2\ x\ 2\ \frac{gpm}{ft^2}\ x\ 1440 = 144{,}000\ gallons\ (5.5\ x\ 10^{-5}\ L)$$

$$Percent\ Backwash = \frac{3{,}240}{144{,}000}\ x\ 100 = 2.25\%$$

III. CONTINUOUS BACKWASH FILTER

Assume hydraulic loading = 5 gpm/ft^2
plant flow = 92 gpm

$$Filter\ Area = \frac{92gpm}{5gpm/ft^2} = 18.4\ ft^2 = 1.71\ m^2$$

Using the application table, a model 3, with a surface area of 19.0 ft^2 (1.76 m^2), would be required. Tank size would be 5.0 ft (1.5 m) diameter. Air flow requirement would be 1.0-2.0 scfm (28-56 1/mm) and sand required would be 5.0 tons (4.5 metric tons).

IV. CARTRIDGE FILTER

Waste Stream Characteristics

Maximum Flow = 400 1pm (100 gpm)
Maximum Operating Temperature = 60 C^0
Design Influent Suspended Solids = 1 ppm
Design Effluent Particle Size = 10 micros
Influent pH = 8.0
The waste stream to be treated also contains residual soluble alum from upstream treatment process and aluminum nitrate(s) and barium chloride(s) which is to be treated by a downstream membrane process. Trace amounts of ainyl alcohol are also present in the waste stream.
(s) = soluble.

Selection of Filter Materials of Construction:

The chemicals in the waste stream are compared to the chemical resistance charts found at the end of this appendix. The chemical resistance chart is compared to polypropylene filter material and based on the comparison polypropylene is compatible with the chemicals in the waste stream.

A review of the, “General Chemical Resistance Chart”, shows that Polypropylene is also compatible with the maximum operating temperature and its resistance to alkalies indicates that the pH of 8 will not impact filter performance.

Therefore, filter materials of construction can be polypropylene. The Vendor A cartridge filter bulletin shows that the filter, filter core and outer filer cage are all constructed of polypropylene. The Vendor A bulletin also indicates that this filter has a 10 micron rating.

Number of Filters Required:

Assume 10 1pm per 2500 mm cartridge filter length (2.5 gpm per 10 inch cartridge filter length) for Vendor A cartridge. The Vendor bulletin indicates that a 2500 mm (10 inch) cartridge length has 0.5 square meter of filter media.

$$\textit{Hydraulic Filter Loading} = \frac{10\ L/\text{min}\ \textit{per filter}}{0.5\ m^2\ \textit{per}\ 2500\ \textit{mm filter}} = 20\ L/(\text{min}\cdot m^2)$$

$$\textit{Total Filter Area} = \frac{378.5\ L/\text{min}}{20.6\ L/(\text{min}\cdot m^2)} = 18.4\ m^2$$

$$\textit{No of}\ 2500\ \textit{mm Filters} = \frac{20\ m^2}{0.5\ m^2\ \textit{per element}} = 40$$

$$\textit{No of}\ 5100\ \textit{mm Filters} = \frac{18.4\ m^2}{1.0\ m^2\ \textit{per element}} = 18$$

$$\textit{No of}\ 7600\ \textit{mm Filters} = \frac{20\ m^2}{1\ m^2\ \textit{per element}} = 20$$

$$\textit{No of}\ 10{,}000\ \textit{mm Filters} = \frac{20\ m^2}{2.0\ m^2\ \textit{per element}} = 10$$

Selection of the filter lengths and number of filters selected may be based on space limitations, operating procedures for changing longer filters and limited overhead space, or filter suppliers standard housing configurations.

Housing Selection:

The materials of construction must be suitable for the waste stream characteristic including temperature. The Vendor A product bulletin has PVC and CPVC housings which are compatible. From the Bulletin the housing should be manufactured of CPVC to give added temperature protection and it should be the 12EFC model which provide flowrates up to 450 L/min (120 gpm) and it should contain 18 – 500 mm (20 inch) filters.

V. BAG FILTER

Waste Stream Characteristics

Maximum Flow = 400 1pm (100 gpm)
Maximum operating Temperature = 60 C^0
Design Influent Suspended Solids = 1 ppm
Design Effluent Particle Size = 10 microns
Influent pH = 8.0
The waste stream to be treated also contains residual soluble alum from upstream treatment process and aluminum nitrate(s) and barium chloride(s) which is to be treated by a downstream membrane process. Trace amounts of amyl alcohol are also present in the waste stream.
(s) = soluble.

Selection of Filter Materials of Construction:

The chemicals in the waste stream are compared to the chemical resistance charts found at the end of this example. The chemical resistance chart is compared to polypropylene filter material and based on the comparison polypropylene is compatible with the chemicals in the waste stream.

A review of the, "General Chemical Resistance Chart", shows that Polypropylene is also compatible with the maximum operating temperature and its resistance to alkalies indicates that the pH of 8 will not impact filter performance.

Therefore, filter materials of construction can be polypropylene. The Vendor B bag filter bulletin shows that the bag filter and bag filter core are all constructed of polypropylene. The Vendor B bulletin also indicates that this filter is available in a 10 micron rating.

Number of Filters Required:

For standard filter vessel model FSP-85, 1-number 2 bag size can handle a maximum flow 800 L/min (200 gpm). The filter hydraulic loading based on the bags surface area of 0.50 m^2 (4.4 ft^2) is calculated below:

$$\textit{Hydraulic Filter Loading} = \frac{800\ L/\min}{0.5\ m^2\ \textit{filter surface area}} = 1600\ L/(\min \cdot m^2)$$

Housing Selection:

The materials of construction must be suitable for the waste stream characteristics including temperature. The Vendor B product bulletin has housings which are compatible. According to the Vendor B data, the FSP-85 unit would be suitable for this application with a number 2 bag.

Comparison to Cartridge Filter Design:

The bag filter requires only one bag as opposed to the 18 cartridge filters required to treat the same waste stream. This significantly reduces disposal cost when a bag filter is used versus cartridge filters.

The bag filter operates at nearly 90 times the hydraulic loading rate for the same throughput.

One additional consideration is that provisions could made to clean the bag filter for reuse and that systems are available in flowrates beyond the scope of this document.

General Chemical Resistance			
Material	**Resistance**	**Max Permissible Temp (Water)**	
		Constant	**Short Term**
Polyvinyl Chloride (PVC, UPVC)	Resistance to most solutions of acids, akalis, and salts and organic compounds miscible with water. Not resistant to aromatic and chlorinated hydrocarbons.	60C 140F	60C 140F
Chlorinated Polyvinyl Chloride (CPVC)	Can be used similarly to PVC but at increased temperatures.	90C 195F	110C 230F
Polypropylene (PP)	Resistant to water solutions of acids, alkalis, and salts, as well as to large number of organic solvents. Unsuitable for concentrated oxidizing acids.	60C 140F	80C 175F
Polyvinylidene (PVDF)	Resistant to acids, solutions of salts, aliphatic, ,aromatic and chlorinated hydrocarbons, alcohols, and halogens. Conditionally suitable for ketones, esters, ethers, organic bases, and alkaline solutions.	90C 195F	110C 130F
Polytetrafluroethylene (PTFE)	Resistant to all chemicals listed in the chart.	140C 285F	150C 300F
Nitrile Rubber (Buna-N)	Good resistance to oil and gasoline. Unsuitable for oxidizing agents.	90C 195F	120C 250F
Butyl Rubber Ethylene Propylene Rubber (EPDM, EPR)	Good resistance to ozone and weather. Especially suitable for aggressive chemicals. Unsuitable for oils and fats.	90C 195F	120C 250F
Chloroprene Rubber (Neoprene •)	Chemical resistance very similar to that of PVC and between that of Nitrile and Butyl rubber.	80C 175F	110C 230F
Fluorine Rubber (Viton •)	The best chemical resistance to solvents of all elastomers.	150C 300F	200C 390F

TABLE C-1. VENDOR A – GENERAL CHEMICAL RESISTANCE.

CHEMICAL	TEMPERATURE				CHEMICAL	TEMPERATURE			
	70 F	100 F	140 F	180 F		70 F	100 F	140 F	180 F
	21 C	38 C	60 C	82 C		21 C	38 C	60 C	82 C
Acetaldehyde	R	R	NR	NR	Ammonia, Liquid	R	R	NR	NR
Acetamide	R	NA	NA	NA	Ammonium, Acetate	R	NR	NR	NR
Acetic Acid, 10%	R	R	R	R	Ammonium Bifluoride	R	R	R	NA
Acetic Acid, 20%	R	R	R	R	Ammonium Bisulfide	NA	NA	NA	NA
Acetic Acid, 50%	R	R	R	R	Ammonium Carbonate	R	R	R	R
Acetic Acid, 80%	R	R	R	R	Ammonium Chloride	R	R	R	R
Acetic Acid, Glacial	R	R	NR	NR	Ammonium Dichromate	NA	NA	NA	NA
Acetic Anhydride	R	R	R	R	Ammonium Fluoride, 10%	R	R	R	NA
Acetone	R	NR	NR	NR	Ammonium Fluoride, 25%	R	NA	NA	NA
Acetonitrile	NA	NA	NA	NA	Ammonium Hydroxide	R	R	R	R
Acetophenone	R	R	NR	NR	Ammonium Metaphosphate	R	R	R	NA
Acetyl Chloride	NR	NR	NR	NR	Ammonium Nitrate	R	R	R	R
Acetyl Nitrile	NA	NA	NA	NA	Ammonium Persulphate	R	R	R	R
Acetylene	R	NA	NA	NA	Ammonium Phosphate	R	R	R	R
Acrylic Emulsions	R	R	R	NA	Ammonium Sulfate	R	R	R	R
Acrylonitrile	R	NR	NR	NR	Ammonium Sulfide	R	R	R	NA
Adipic 10S Acid	R	NR	NR	NR	Ammonium Thiocyanate	R	R	R	NA
Alcohol, Allyl	R	NA	NA	NA	Amyl Acetate	NR	NR	NR	NR
Alcohol, Amyl	R	R	R	R	Amyl Chloride	NR	NR	NR	NR
Alcohol, Benzyl	R	R	R	NA	Aniline	R	R	R	R
Alcohol, Butyl, Primary	R	R	R	R	Aniline Chlorohydrate	NR	NR	NR	NR
Alcohol, Butyl, Secondary	R	R	R	NA	Aniline Dyes	R	R	R	R
Alcohol, Diacetone	R	NR	NR	NR	Aniline Hydrochloride	NR	NR	NR	NR
Alcohol, Ethyl	R	R	R	R	Anthraquinone	NR	NR	NR	NR
Alcohol, Hexyl	R	R	NA	NA	Anthraquinone Sulfonic Acid	NR	NR	NR	NR
Alcohol, Isopropyl	R	R	R	NR	Antimony Trichloride	R	R	R	R
Alcohol, Methyl	R	R	R	R	Apple Juice	R	R	R	R
Alcohol, Propargyl	NR	NR	NR	NR	Aqua Regia	R	NR	NR	NR
Alcohol, Propyl	R	R	R	R	Arsenic Acid	NR	NR	NR	NR
Allyl Chloride	R	NA	NA	NA	Aryl Sulfonic Acid	NA	NA	NA	NA
Alum	R	R	R	R	Asphalt Liquid	NA	NA	NA	NA
Alum, Ammonium	R	R	R	NA	Barium Carbonate	R	R	R	R
Alum, Chrome	R	R	R	NA	Barium Chloride	R	R	R	R
Alum, Potassium	R	R	R	NA	Barium Hydrate	NA	NA	NA	NA
Aluminum Chloride	R	R	R	R	Barium Hydroxide	R	R	R	R
Aluminum Fluoride	R	R	R	R	Barium Nitrate	NA	NA	NA	NA
Aluminum Hydroxide	R	R	R	R	Barium Sulfate	R	R	R	NA
Aluminum Nitrate	R	R	R	R	Barium Sulfide	R	R	R	NA
Aluminum Oxychloride	R	R	NA	NA	Beer	R	R	R	R
Aluminum Sulfate	R	R	R	R	Beet Sugar Liquors	R	R	R	R
Ammonia, Aqu. 10%	R	R	R	R	Benzaldehyde, 10%	R	NR	NR	NR
Ammonia, Gas	R	R	R	NA	Benzaldehyde, above 10%	R	NA	NA	NA

R = Recommended for use.
NR = Not recommended for use.
NA = No available test data. User should run test prior to use.

TABLE C-2. VENDOR B - CHEMICAL RECOMMENDATIONS.

APPLICATIONS

For use as a final filter in industrial applications or as a pre-filter in membrane filtration systems

Absolute ratings can be obtained under specified conditions

OPERATING CHARACTERISTICS

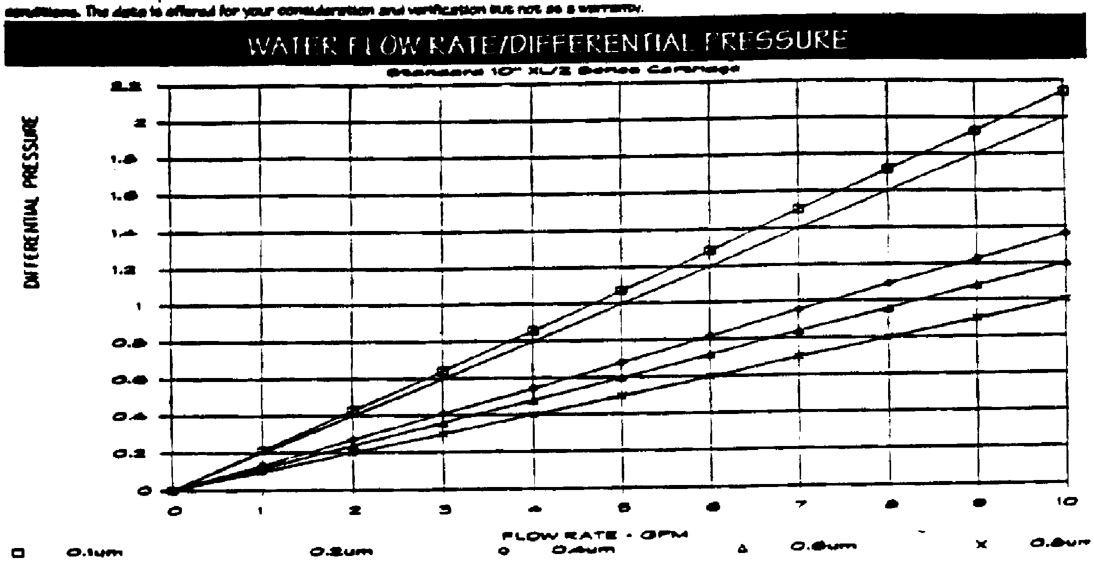
Water Flow Rate - See Charts

Maximum Operating Temperature - 175F

Maximum Differential Pressure - 100psi

Cartridges pass USP XXI Class VI Plastic Tests, as well as, tests for cytotoxicity, hemolysis, and pyrogenicity

Note: The information presented is believed to be reliable; however it may vary under different filtration conditions. The data is offered for your consideration and verification but not as a warranty.



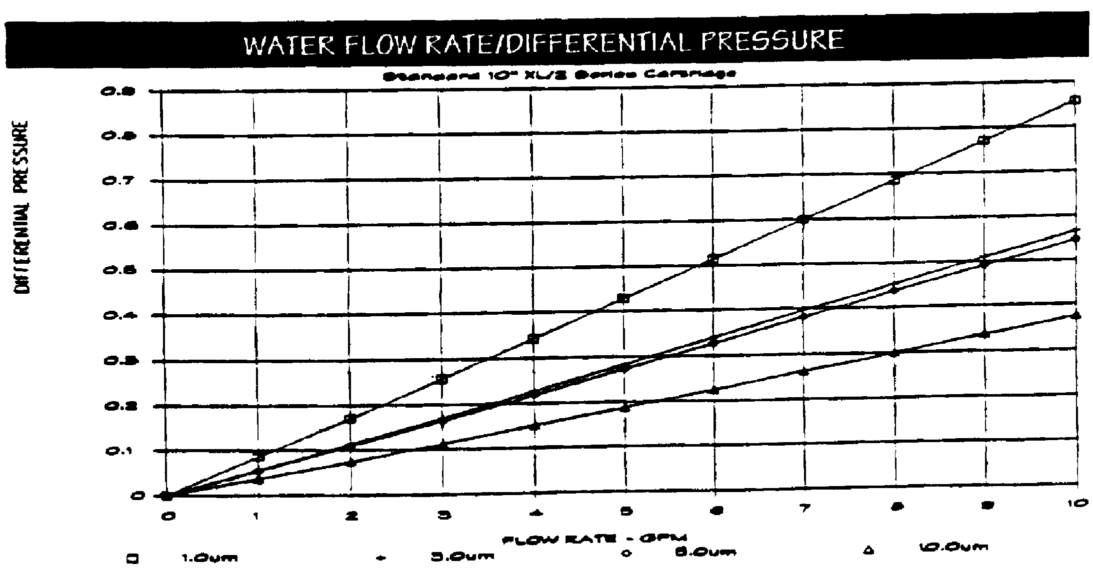


FIGURE C-3. VENDOR B - OPERATING CHARACTERISTICS.

PLEATED CARTRIDGE FILTERS

CARTRIDGE CONFIGURATIONS

DOE Flat Gasket Standard Seal
Internal -020 O-ring seal
External -222 O-ring seal
External -222 O-ring seal, Bayonet Base
External -226 O-ring seal
External -226 O-ring seal, Bayonet Base

SPECIFICATIONS

Dimensions:
- 2.77 inches outside diameter
- 1 inch core diameter
- Lengths: 10, 20, 30, 40 inches

Effective Filtration Area:
- 10 inch - 5 square feet
- 20 inch - 11 square feet
- 30 inch - 16 square feet
- 40 inch - 22 square feet

Micron Ratings
- 10.0, 5.0, 3.0, 1.0, 0.8, 0.6, 0.4, 0.2, 0.1
- Liquid nominal ratings

FIGURE C-4. VENDOR A - PLEATED CARTRIDGE FILTERS.

Instructions for Using Nomograph

To calculate the pressure drop across a 10-inch cartridge :or a fluid of a known viscosity:

1. Draw a line from the desired flow rate through the Viscosity line and extend it to the Index line.
2. Draw a second line from the point where the first line intersects the Index Line to the Micron Rating number of the cartridge. The point where the second line crosses the Differential Pressure line is the critical value. For multi-cartridge systems, multiply the Flow Rate in nomograph by the equivalent number of 10-inch cartridges in use.

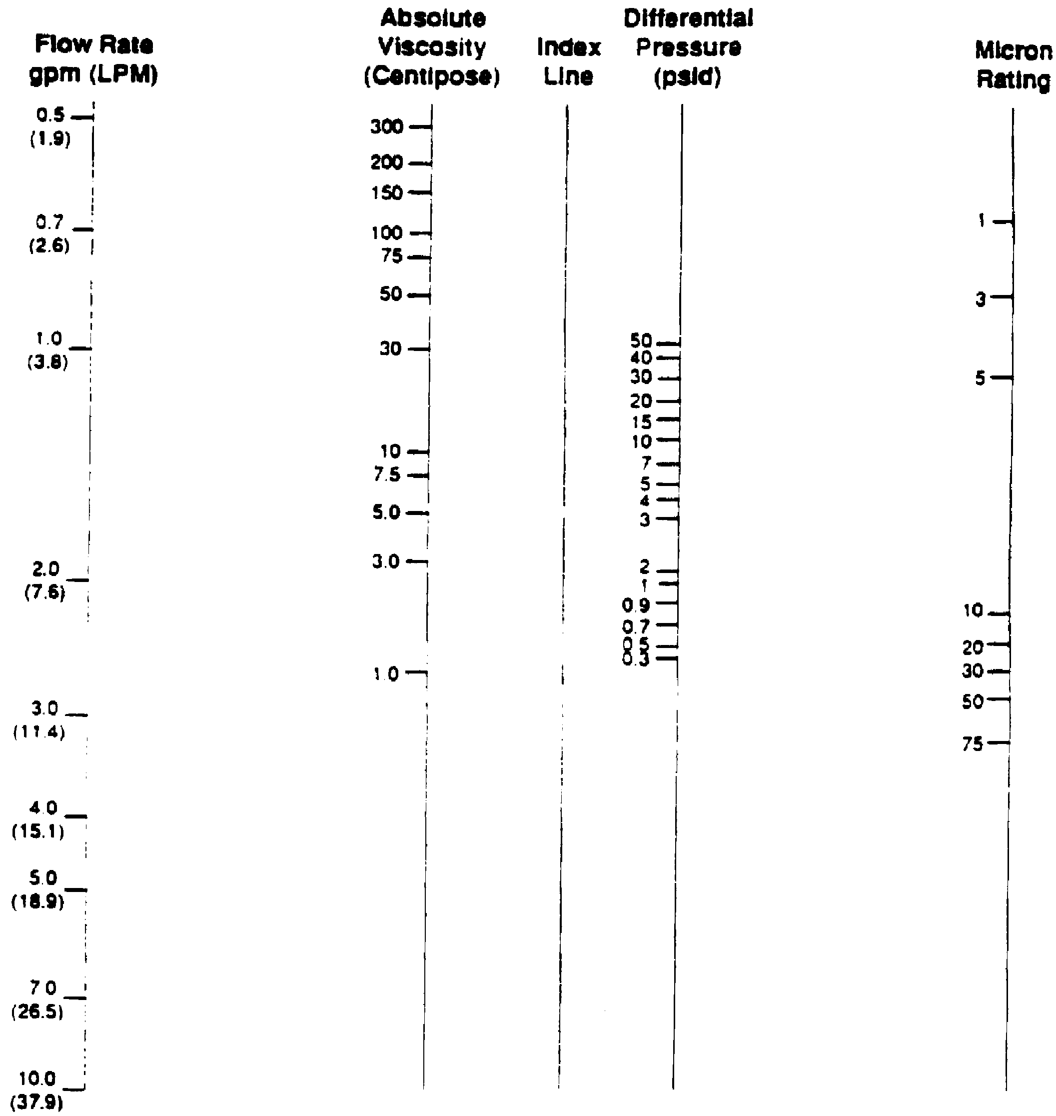


FIGURE C-5. VENDOR C - NOMOGRAPH FOR AQUEOUS FLUIDS.

CARTRIDGE FILTER HOUSINGS

- Utilizes 10 to 40 inch cartridge filters.
- Flow rate capacities:

  6 EFC - up to 60 gpm
  12 EFC - up to 120 gpm
  18 EFC - up to 180 gpm
  24 EFC - up to 240 gpm

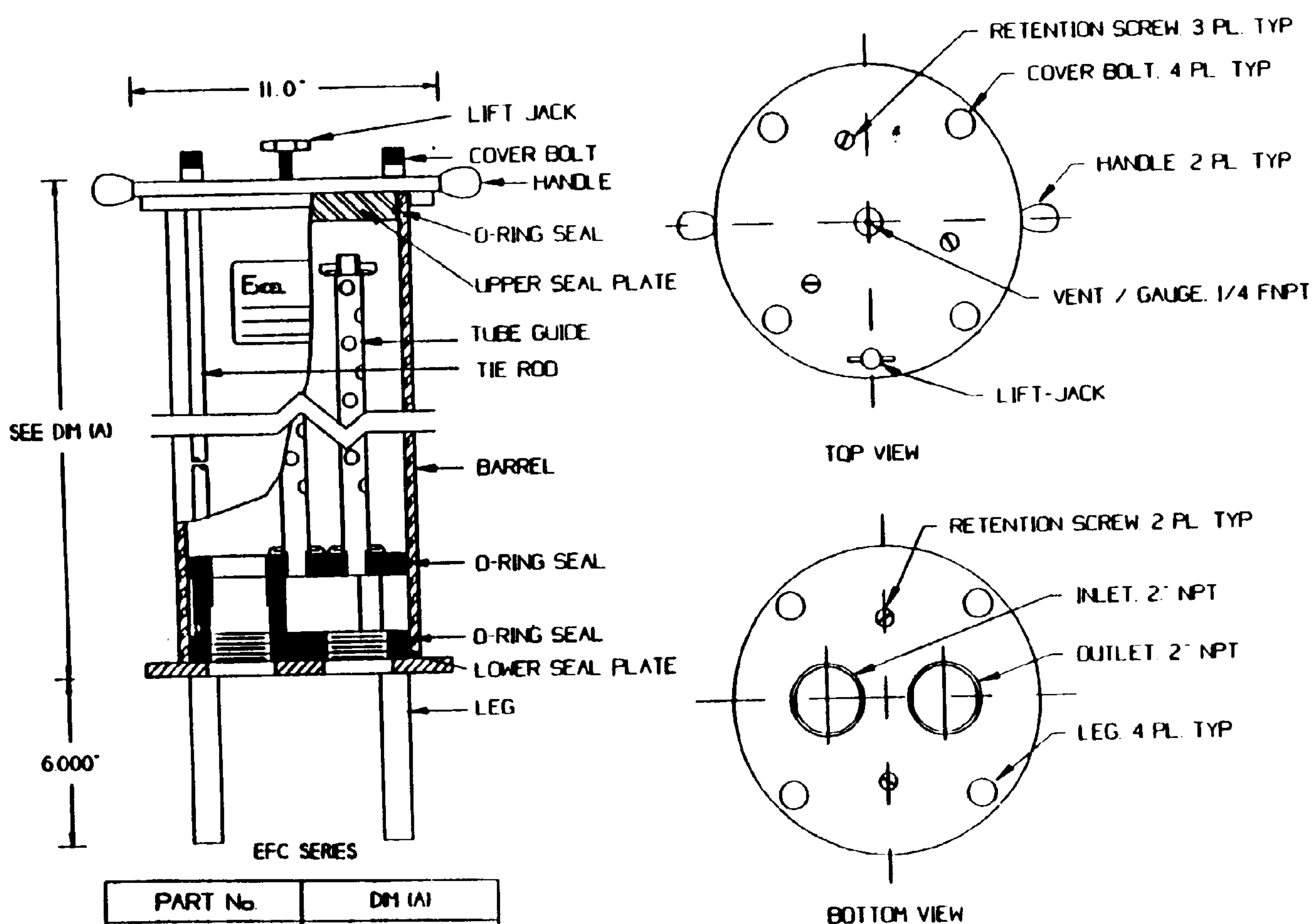
SPECIFICATIONS

1. Vessels are designed to meet and/or exceed ASME CODE, Section X and conform to California Barclays Code.
2. Operating Conditions:
   (a) Pressure: 150 psi
   (b) Temperature: 150 F
   (c) Fluids with a pH of 2-13.
3. Each housing is pressure tested at 300 psi.
4. The vessel barrel is fabricated using Dow Derakane 411-45, a flexible, fatigue resistant vinylester.
5. All wetted materials meet the requirements of FDA CFR Title 21.
6. Vent connection is standard on all housing.

STANDARD SERIES

- 6 EFC - 10 inch cartridge filter
  120 EFC - 20 inch cartridge filter
  18 EFC - 30 inch cartridge filter
  24 EFC - 40 inch cartridge filter
- 2 inch NPT Inlet/Outlet
- Buna O-ring Seals
- Anodized Aluminum/300ss Series
- Externals

FIGURE C-6. VENDOR A - CARTRIDGE FILTER HOUSING.



PART No.	DIM (A)
6EFC1	19.0 INCHES
12EFC2	29.0 INCHES
18EFC3	39.0 INCHES
24EFC4	49.0 INCHES

NOTE: 2" NPT STANDARD INLET AND OUTLET

NOTE: 2" OR 3" FLANGE OPTIONAL

NOTE: ALL DIMENSIONS ARE NOMINAL UNLESS OTHERWISE NOTED

FIGURE C-7. TYPICAL CROSS SECTION OF MULTI ELEMENT CARTRIDGE FILTER HOUSING.

FILTER FABRIC PROPERTIES

Physical-Chemical-Temperature

Fabric	Specific Gravity	Tensile Strength	Abrasion & Flex	Weak Acids	Strong Acids	Weak Alkali	Strong Alkali	[illegible] Solvents	[illegible] Temperature °F
Cotton	1.55	44–109	Fair	Poor	Poor	Excellent	Excellent	Good	200–240
Polyester	1.38	64–124	Very Good	Very Good	Good	Good	Poor	Good	275–325
Glass	2.56	200–215	Poor	Excellent	Good	Fair	Poor	Excellent	500–600
Nylon	1.14	58–128	Excellent	Fair	Poor	Excellent	Excellent	Good	275–300
Nomex	1.14	58–128	Very Good	Fair	Poor	Excellent	Excellent	Good	400–450
Polypropylene	0.91	50–85	Very Good	Excellent	Excellent	Excellent	Excellent	Fair	200–220
Saran	1.69	15–44	Good	Excellent	Excellent	Excellent	Excellent	Poor	160–185
Teflon	2.30	47	Poor	Excellent	Excellent	Excellent	Excellent	Very Good	450–500

This guide contains general information. Actual use or soak tests should be performed wherever possible

TABLE C–3. VENDOR A – FILTER FABRIC PROPERTIES.

FILTER BAGS

1 Fibers & Media	2 Micron Rating
PECG–polyester/cotton	1, 3
PEIF–polyester inserted	1, 3, 5, 10, 15, 25, 50, 75, 100, 200
PENF–polyester non–inserted	5, 10, 15, 25, 50, 75, 100
PEIG–polyester inserted glazed	1, 3, 5, 10, 15, 25, 50, 75, 100, 200
PENG–polyester non–inserted glazed	5, 10, 15, 25, 50, 75, 100
V–rayon–viscose felt	3, 5, 10 15, 25
TFE–teflon felt	10, 25, 50
N–nylon felt	5, 10, 25, 50, 100
POIF–polypropylene inserted	1, 3, 5, 10, 25, 50, 100
POIG–polypropylene inserted glazed	1, 3, 5, 10, 25, 50, 100
PONG–polypropylene non–inserted glazed	5, 10, 25, 50, 100
POMF–polypropylene micro–fiber	2A, 10A, 25A, 0A
HT–nylon nomex felt	5, 10, 25, 50, 100
PEM–polyester multifilament mesh	75, 100, 125, 150, 200, 250, 400, 600, 800
PEMO–polyester monofilament mesh (special order)	5, 10, 25, 50, 75, 100, 150, 200, 250, 400, 600, 800
NM–nylon multifilament mesh	100,150, 800
MNO–nylon monofilament mesh	5, 10, 25, 35, 50, 65, 75, 90, 100, 125, 150, 175, 200, 250, 300, 400, 600, 800
PMO–polypropylene monofilament mesh	250, 300, 400, 600, 800
S–saran monofilament mesh	300, 600, 800

TABLE C–4. VENDOR A – BAG MEDIA AND MICRON RATINGS.

FILTER BAGS

3 Bag Cover	4 Bag Size Number
P-plain (no cover)	1- #1 size bag
PEM-polyester multi-filament cover	2- #2 size bag
G-fiber free finish	3- #3 size bag
NMO-nylon monofilament cover	4- #4 size bag
NM-nylon multifilament cover	5- #5 size bag
Cerex-spun bonded nylon	6- #6 size bag
M-muslin cover	7- #7 size bag
	8- #8 size bag
	9- #9 size bag

5 Bag Design	6 Suffix
P-Polyloc	SS
S- metal retaining ring-snap collar design	316 ss ring
PC-1-fits #1 cuno housing	PVC
PC-2-fits #2 cuno housing	PVC coated ring
CO-fits Commercial filter housing	R
RP-fits Ronnigen-Petter housing	reverse collar
RP-P-Plastic ring for above	TN
	tripple needle seam
	A
	adapter head
	AUTO
	inside seams
	CH
	cotton handle
	L
	loops

TABLE C-5. VENDOR A - BAG COVER AND DESIGN DATA.

		Micron Ratings																							
Fiber	Material	1	3	5	10	15	25	35	50	65	75	90	100	125	150	175	200	250	300	400	600	700	800	1200	1500
Polyester/cotton	Felt	x	x																						
Polyester	Felt	x	x	x	x	x	x		x		x		x				x								
Rayon-Viscose	Felt		x	x	x		x																		
Nylon	Felt			x	x		x		x				x												
Polypropylene	Felt	x	x	x	x		x		x				x												
Teflon	Felt				x		x		x																
Nylon(Nomex)	Felt			x	x		x		x				x												
Polypropylene	Micro-Fiber		x		x		x																		
Nylon	Multifilament Mesh												x		x								x		
Nylon	Monofilament Mesh			x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		
Polypropylene	Monofilament Mesh																	x	x	x	x		x		
Polyester	Multifilament Mesh										x		x	x	x		x	x		x	x		x	x	x
Polyester	Monofilament Mesh			x	x		x		x		x		x		x		x	x		x	x		x		
Saran	Monofilament Mesh																		x		x		x		

TABLE C-6. VENDOR B - BAG MEDIA AND MICRON RATINGS.

Comparative Particle Size

U.S. Mesh	Inches	Microns
10	.0787	2000
12	.0661	1680
14	.0555	1410
16	.0469	1190
18	.0394	1000
20	.0331	841
25	.0280	707
30	.0232	595
35	.0197	500
40	.0165	420
45	.0138	354
50	.0117	297
60	.0098	250
70	.0083	210
80	.0070	177
100	.0059	149
120	.0049	125
140	.0041	105
170	.0035	88
200	.0029	74
230	.0024	63
270	.0021	53
325	.0017	44
400	.0015	37

Filter Bag Data

Bag size Number	1	2	3	4	5	6
Surface Area Per Bag - ft²/m²	2.0/.19	4.4/.41	0.5/.05	1.0/.09	5.0/.46	2.5/.23
Volume Per Bag - gal/liter	2.1/7.9	4.6/17.3	.37/1.4	.67/2.5	5.3/20.1	2.5/9.3
Bag Diameter - inch/cm	7/17.8	7/17.8	4/10.2	4/10.2	7/17.8	7/17.8
Bag Length - inch/cm	16.5/41.9	32/81.3	9/22.9	15/38.1	32.5/82.6	15.75/40.0
FSI Filter Model Number	FSP-40 FS-40	FSP-85 FSP-250 and all multi-hole vessels	FSP-20 FS-20	FSP-35 FS-35	FS-90PVC	FS-50PVC

FIGURE C-8. VENDOR B - BAG HYDRAULIC AND GENERAL DATA.

SPECIFICATIONS

Model No.	No. of Filter Bags	Bag Size No.	Surface area per bag, ft.^{2}	Surface area per filter, ft.^{2}	Inlet and Outlet Size	Max. flow rate, GPM
1	1	1	2.0	2.0	1" thru 4"	90
2	1	2	4.4	4.4	1" thru 4"	200

- Standard 2" inlet & outlet
- Specific locations and sizes up to 4" available on request
- 4 standard styles
- Stock vessels available in:
  1. Carbon steel
  2. 304 stainless steel
- 316 stainless steel and electroless nickel plated carbon steel vessels available on request
- Standard 150 or 300 PSI ASME code stamp (meets OSHA requirements) or customer specification
- Filter bags available rated 1 to 1500 microns
- Gasket materials include Buna N, Neoprene, EPR, Viton, Teflon

ADDITIONAL FEATURES

- Single gasket seal
- Positive bag sealing
- Heavy-duty baskets (standard)
- Can be supplied with steam jackets, extra-length legs and corrosion allowance
- Mesh lined baskets available for straining applications

FIGURE C-9. VENDOR B – SINGLE BAG FILTER VESSELS.

Model No.	No. of Bags	Bag Size No.	Surface Area per Bag, sq ft.	Surface Area per Filter, sq ft.	Inlet & Outlet Size, in.	Max. Flow Rate GPM*
B-1	1	3	0.5	0.5	1	25
B-2	1	4	1.0	1.0	1	45
B-3	1	1	2.0	2.0	2	90
B-4	1	2	4.4	4.4	2	200
B-5	2	2	4.4	8.8	3-4	400
B-6	3	2	4.4	13.2	3-6	600
B-7	4	2	4.4	17.6	4-6	800
B-8	5	2	4.4	22.0	4-8	1000
B-9	6	2	4.4	26.4	4-8	1200
B-10	7	2	4.4	30.8	6-8	1400
B-11	8	2	4.4	35.2	8-10	1600
B-12	10	2	4.4	44.0	8-10	2000
B-13	12	2	4.4	52.8	8-10	2400
B-14	14	2	4.4	61.6	10-12	2800
B-15	16	2	4.4	70.4	10-12	3200
B-16	18	2	4.4	79.2	10-14	3600
B-17	20	2	4.4	88.0	10-14	4000
B-18	22	2	4.4	96.8	10-14	4400
B-19	24	2	4.4	105.6	10-14	4800

* Note: The maximum flow rate GPM column is the maximum flow rate recommended thru the vessel without filter bags installed using water as a base. Any increase in fluid viscosity, or the installation of filter bags, will reduce the max. GPM figures significantly.

TABLE C-7. VENDOR B - STANDARD VESSEL MODELS.